Chapter 4

Sodium Dichromate Production

The sodium chromate and dichromate (also known as bichromate) production sector consists of two facilities that, as of September 1989, were active and reported generating a special mineral processing waste: treated residue from roasting/leaching of chrome ore. Prior to treatment, the roast/leach residue is not a special waste and thus, is subject to applicable RCRA Subtitle C requirements (see 55 FR 2322, January 23, 1990.)[1] Facilities that are no longer operational, such as the Allied-Signal facility in Baltimore, MD, are not addressed in this report. The data included in this chapter are discussed in additional detail in a technical background document in the supporting public docket for this report.

4.1 Industry Overview

Sodium dichromate, converted from sodium chromate, is the primary feedstock for the production of chromium-containing chemicals and pigments. Chromium-containing chemicals (e.g., chromic acid, basic chromium sulfate, tanning compounds) are used in chromium plating, etching, leather tanning, water treatment, and as catalysts. Other uses of chromium-containing chemicals are in drilling operations to provide drilling mud fluidity and in wood preservative processes to bind copper and arsenic to wood. Chromium pigments represent the largest use of chromium in the chemical industry, with sodium dichromate used to manufacture a multitude of pigments (e.g., chrome green and yellow, zinc chromate) that are used in paints and inks, often for materials that require corrosion inhibition.[2]

The two sodium dichromate production facilities studied in this report are the Corpus Christi, Texas plant operated by American Chrome and Chemicals (ACC) and owned by Harrisons and Crossfield Inc. (Harcross), and the Castle Hayne, North Carolina plant owned and operated by Occidental Chemical Corporation (OCC). The ACC facility initiated operations in 1962 and was modernized in 1985; the OCC facility began operations in 1971 and was modernized in 1982. The annual production capacity, total 1988 production, and rate of capacity utilization for the two facilities as reported in the SWMPF Surveys have all been designated confidential by the facilities and, therefore, are not reported in this document.[3] A published data source lists the annual sodium dichromate production capacity[4] of the ACC plant at 41,000 metric tons and the OCC plant as 109,000 metric tons.[5] According to Bureau of Mines sources, long term capacity utiltzation (1990 to 1995) is forecast to be 100 percent of capacity.[6]

Because these two facilities have classified their production statistics as confidential, no specific information can be given on production trends in the sodium chromate and dichromate industries. The U.S. Bureau of Mines, however, reports that apparent U.S. consumption of chromium has risen from 343,000 metric tons in 1985 to 540,000 metric tons in 1989.[7]

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[1] The residue from roasting/leaching of chrome ore is not "low hazard" (as defined by EPA for purposes of determining the scope of the Mining Waste Exclusion as it applies to mineral processing wastes) when it is removed from the production process and, thus, is not a special waste at the point of generation. However, after treatment (pH adjustment and sulfide reduction), as employed by the two facilities, the residue is "low hazard" and therefore is a special waste because it is also high volume.

[2] Bureau of Mines, 1987. Minerals Yearbook, Ed.; p. 373.

[3] American Chrome and Chemicals and Occidental Chem. Corp. Company Responses to the "National Survey of Solid Wastes from Mineral Processing Facilities," U.S. EPA, 1989.

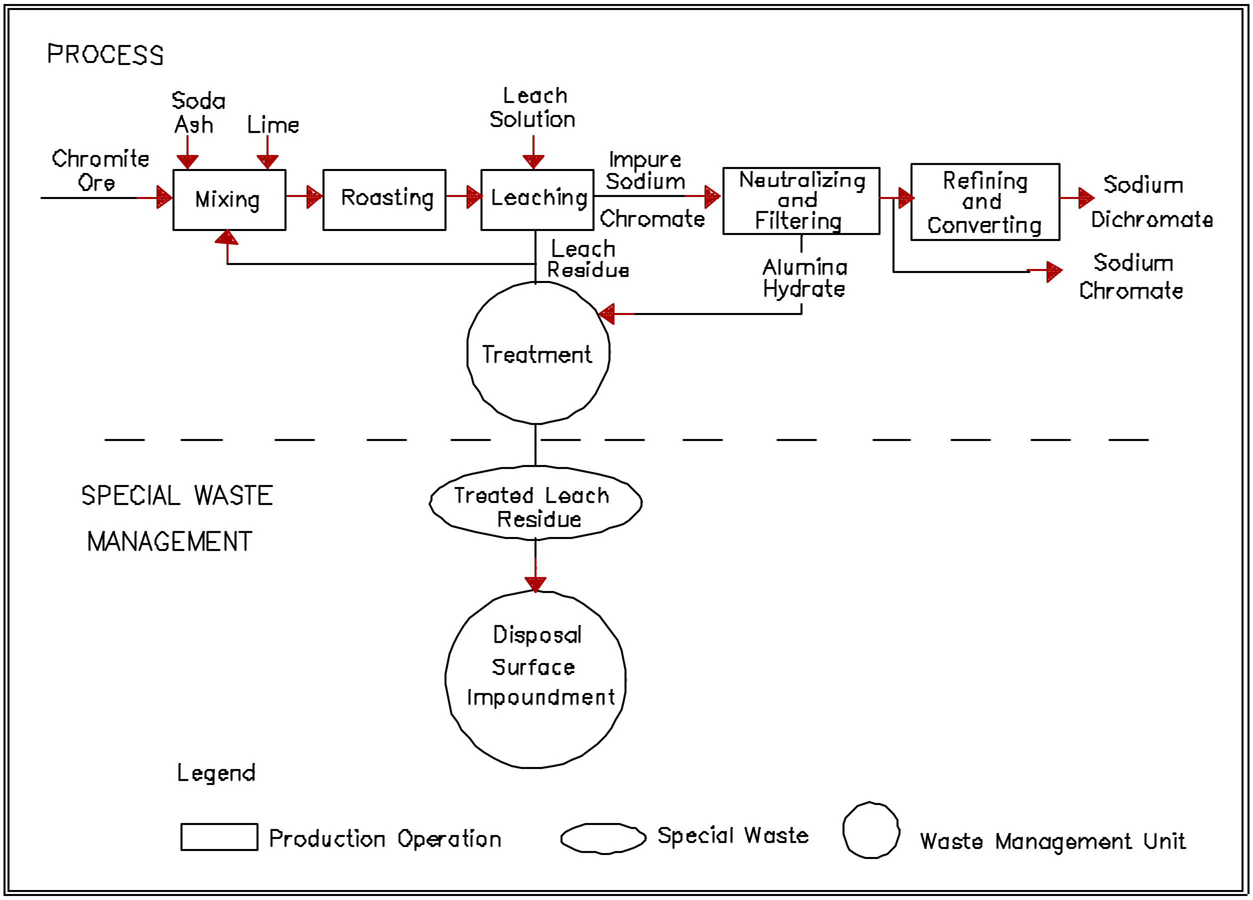
[4] Capacities are on a 100 percent sodium dichromate basis and include sodium chromate.

[5] SRI International, 1987. Directory of Chemical Producers--United States, Ed.; p. 964.

[6] Bureau of Mines. 1990. Personal communication with Commodity Specialist John Papp.

[7] John F. Papp, 1987. U.S. Bureau of Mines, "Chromium," Minerals Yearbook, Ed., pp. 221, 223.

Exhibit 4-1
Sodium Dichromate Production



Substitutes for chromium chemicals result in increased costs or poor performance.[8] Thus, the future demand for sodium chromate and dichromate will fluctuate directly with the future demand for chromium pigments and the chromium containing chemicals used in chromium plating, etching, tanning, and water treatment, and as catalysts. The chromium chemical industry has historically shown a slow but steady growth rate;[9] there is no indication that this trend will change in the future.

Sodium chromate and dichromate are produced by a process in which ground chrome ore and soda ash are mixed (lime and/or leached calcine are sometimes added as well), roasted in an oxidizing atmosphere, and leached with weak chromate liquor or water, as shown in Exhibit 4-1.[10] The resulting leach liquor is separated from the remaining leach residue. The roasting/leaching sequence is repeated at the ACC facility; that is, two complete chromium extraction cycles are performed prior to removal of the residue. The leach residue is then treated, as discussed below. The treatment

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[8] John F. Papp, 1990. U.S. Bureau of Mines, "Chromium," Mineral Commodity Summaries, Ed., p. 45.

[9] John F. Papp, 1985. U.S. Bureau of Mines, "Chromium," Mineral Facts and Problems, Ed., p. 152.

[10] Bureau of Mines, 1985. Mineral Facts and Problems, Ed.; p. 144.

residue from this operation is the special waste; it is disposed on-site at both facilities.[11] The leach solution contains unrefined sodium chromate; this liquor is neutralized and then filtered to remove metal precipitates (primarily alumina hydrate).[12] The alumina-free sodium chromate may be marketed, but the predominant practice is to convert the chromate to the dichromate form. The OCC facility uses a continuous process that involves treatment with sulfuric acid, evaporation of sodium dichromate, and precipitation of sodium sulfate. Sodium sulfate may be sold as a byproduct or disposed; the dichromate liquor may be sold as 69 percent sodium dichromate solution or returned to the evaporators, crystallized, and sold as a solid. The ACC plant uses carbon dioxide (CO_2) to convert the chromate to dichromate; this process has the advantage of not generating a sulfate sludge.

Treatment of the leach residue consists of pH adjustment and sulfide reduction. The ACC facility pumps the leach residue directly to a dedicated treatment unit, in which sulfuric acid and sodium sulfide are used to induce the desired chemical changes in the residue, while at the OCC plant, the untreated residue is pumped to a wastewater treatment plant which receives, and apparently combines, several other influent streams prior to treatment with several different chemical agents. At both plants, the treated residue is pumped in slurry form to disposal surface impoundments.

4.2 Waste Characteristics, Generation, and Current Management Practices

The special mineral processing waste generated by sodium dichromate production, treated residue from roasting/leaching of chrome ore, is a solid material, though it typically is generated as a slurry containing particles between 2 mm and about 8 cm (3 inches) in diameter. The treated roast/leach residue is composed primarily of metallic oxides, such as those of iron, aluminum, silicon, magnesium, and chromium, as well as sulfates.[13] The residue treatment process at both facilities includes a step to reduce hexavalent chromium (Cr VI) to the trivalent form (Cr III), and to lower the pH of the waste. During its 1989 sampling visit, EPA observed that the residue (as disposed) has a strong sulfide odor that is indicative of reducing conditions.

Using available data on the composition of the treated residue, EPA evaluated whether the residue exhibited any of the four characteristics of hazardous waste: corrosivity, reactivity, ignitability, and extraction procedure (EP) toxicity. Based on these data and professional judgment, the Agency does not believe the chromium residue is corrosive, reactive, or ignitable. Further, based on EP and SPLP leach test data for one sample from the ACC facility, the chromium residue does not exhibit the characteristic of EP toxicity. Using the EP test, the concentrations of all eight inorganic constituents with the EP toxicity regulatory levels were one to two orders of magnitude below the regulatory levels.

Both companies generating this waste indicated that waste generation rate data were confidential business information. Using alternate sources, EPA estimates the total generation to be approximately 102,000 metric tons/year (mt/yr); the estimated waste to product ratio is 0.68 metric ton of treated residue to each metric ton of sodium dichromate.

The waste management practice used at both sodium dichromate production facilities is the disposal of the treated roast/leach residue in large surface impoundments.[14] In these impoundments, the treated roast/leach residue is settled out; the water is removed, treated, and discharged at the OCC facility, and is typically left in the impoundment (evaporates) at the ACC facility. The settled treated roast/leach residue is not removed from the impoundments but accumulates in place. The volume of treated roast/leach residue accumulated on-site at the two sodium dichromate plants is estimated to total more than 1 million metric tons; the facilities have reported accumulations of 54,000 cubic

[11] American Chrome and Chemicals and Occidental Chemical Company Responses to the "National Survey of Solid Wastes from Mineral Processing Facilities," U.S. EPA, 1989.

[12] Marks, 1978. Encyclopedia of Chemical Technology, Marks, et al., editors; Wiley Interscience, New York, NY, pp. 93-94.

[13] Occidental Chemical Corp. Company Responses to the "National Survey of Solid Wastes from Mineral Processing Facilities," U.S. EPA, 1989.

[14] The OCC impoundment at Castle Hayne is actually a quarry. The treated roast/leach residue is co-managed in this quarry with tailings from another on-site operation (identity is confidential). The ACC impoundment is termed a residue disposal area.

meters (1.9 million cubic feet) and 440,000 cubic meters at ACC and OCC, respectively. Other waste streams are co-managed with the treated roast/leach residue at these facilities.

The average surface area of these impoundments is 254,000 square meters (62.8 acres) with a depth of 7.3 meters (24 feet); the specific impoundments range in surface area from 22,000 square meters and a depth of 2.5 meters for ACC/Corpus Christi's residue disposal area to a surface area of 486,000 square meters and a depth of 12 meters at OCC/Castle Hayne's quarry. Neither facility uses a liner or a leachate collection system, and only Occidental has surface and ground-water monitoring.

4.3 Potential and Documented Danger to Human Health and the Environment

This section addresses two of the study factors required by §8002(p) of RCRA: (1) potential danger (i.e., risk) to human health and the environment; and (2) documented cases in which danger to human health or the environment has been proven. Overall conclusions about the hazards associated with treated chromium roast/leach residue are provided after these two study factors are discussed.

4.3.1 Risks Associated with Treated Residue from Roasting/Leaching of Chrome Ore

Any potential danger to human health and the environment from the treated residue from roasting/leaching of chrome ore depends on the presence of toxic constituents in the waste that may pose a risk and the potential for exposure to these constituents.

Constituents of Potential Concern

EPA identified chemical constituents in the treated residue from roasting/leaching of chrome ore that may potentially present a hazard by collecting data on the composition of the waste and evaluating the intrinsic hazard of the residue's chemical constituents.

Data on Treated Residue from Roasting/Leaching of Ore Composition

EPA's characterization of the treated roast/leach residue and its leachate is based on data from a 1989 sampling and analysis effort by EPA's Office of Solid Waste (OSW). These data provide information on the concentrations of 20 metals in samples of both the treated residue and leachate (e.g., EP-toxicity procedure, SPLP). Wastes from both sodium dichromate production plants within the scope of this study were sampled and analyzed.

Data on constituent concentrations in solid samples of the waste from the OCC plant are not available; therefore, concentrations in solid samples cannot be compared for the two facilities. On the other hand, concentrations from leachate analyses of the treated roast/leach residue were available for both facilities and generally are consistent across the two facilities and two types of leach tests (i.e., EP and SPLP).

Process for Identifying Constituents of Potential Concern

As discussed in Section 2.2.2, the Agency evaluated the waste composition data summarized above to determine if treated chromium roast/leach residue contains any chemical constituents that may pose an intrinsic hazard, and to narrow the focus of the risk assessment. The Agency performed this evaluation by first comparing constituent concentrations to the screening criteria and then by evaluating the environmental persistence and mobility of the constituents present in concentrations that exceed the criteria. These screening criteria were developed using assumed scenarios that are likely to overestimate the extent to which constituents in the residue are released to the environment and migrate to possible exposure points. As a result, this process eliminates from further consideration those constituents that clearly do not pose a risk.

Exhibit 4-2
Potential Constituents of Concern in Treated Chromium Roast/Leach Ore Residue Leachate[(a)]

Potential Constituents of Concern	No. of Times Constituent Detected/No. of Analyses for Constituent	Screening Criteria[(b)]	No. of Analyses Exceeding Criteria/ No. of Analyses for Constituent	No. of Facilities Exceeding Criteria/ No. of Facilities Analyzed for Constituent
Chromium	2 / 2	Resource Damage Aquatic Ecological	2 / 2 1 / 2	2 / 2 1 / 2
Vanadium[(c)]	2 / 2	Human Health Resource Damage	1 / 2 1 / 2	1 / 2 1 / 2
Aluminum[(c)]	2 / 2	Aquatic Ecological	2 / 2	2 / 2
Manganese	1 / 2	Resource Damage	1 / 2	1 / 2
Arsenic[(c)]	1 / 2	Human Health*	1 / 2	1 / 2

(a) Constituents listed in this table are present in at least one sample from at least one facility at a concentration that exceeds a relevant screening criterion. The screening criteria values are shown in Exhibit 2-3 in Chapter 2 of this report. Constituents that were not detected in a given sample were assumed not to be present in the sample. Unless otherwise noted, the constituent concentrations used for this analysis are based on EP leach test results.

(b) Human health screening criteria are based on cancer risk or noncancer health effects. "Human health" screening criteria noted with an "*" are based on a 1×10^{-5} lifetime cancer risk; others are based on noncancer effects.

(c) Data for this constituent are from SPLP leach test results.

The Agency used three categories of screening criteria that reflect the potential for hazards to human health, aquatic organisms, and air and water resources (see Exhibit 2-3). Given the conservative (i.e., overly protective) nature of these screening criteria, contaminant concentrations in excess of the criteria should not, in isolation, be interpreted as proof of hazard. Instead, exceedances of the criteria indicate the need to evaluate the potential hazards of the waste in greater detail.

Identified Constituents of Potential Concern

Analysis of solid samples of the treated roast/leach residue indicates that none of the waste's constituents are present at levels above the screening criteria. That is, even under conservative release and exposure conditions, the residue solids do not appear to contain any constituents in concentrations that could pose a significant risk.

Exhibit 4-2 presents the results of the comparisons for treated residue leachate analyses, and lists all constituents for which sample concentrations exceed a screening criterion. Chromium, vanadium, aluminum, manganese, and arsenic are present at concentrations equal to or slightly greater than at least one of their respective screening criteria. All of these constituents are inorganics that do not degrade in the environment.

None of the constituents are present at a concentration more than five times a screening criterion, and arsenic is present at a concentration that is just equal to its human health screening criterion. Vanadium and arsenic leachate concentrations are high enough that, if the leachate migrated to drinking water sources with only a 10-fold dilution, long-term ingestion of untreated drinking water could cause adverse health effects. If the leachate is released and diluted by only a factor of 10, chromium, vanadium, and manganese concentrations could potentially render affected ground or surface waters unsuitable for a variety of uses (e.g., direct human consumption, irrigation, livestock watering). Chromium and aluminum are present in the treated residue leachate at concentrations that, if released to surface waters with a 100-fold dilution or less, could exceed criteria for the protection of aquatic life. It is important to clarify that, while the concentrations of these five constituents exceed the conservative screening criteria, no constituents were measured in concentrations that exceed an EP-toxicity regulatory level.

These exceedances of the screening criteria, by themselves, do not demonstrate that the residue poses a significant risk, but rather indicate that the waste may present a hazard under a very conservative, hypothetical set of release, transport, and exposure conditions. To determine the potential for the residue to cause significant impacts, EPA proceeded to the next step of the risk assessment to analyze the actual conditions that exist at the facilities that generate and manage the waste.

Release, Transport, and Exposure Potential

This analysis evaluates the baseline hazards of the waste as it was generated and managed at the two sodium dichromate production plants in 1988. It does not assess the hazards of off-site use or disposal of the treated residues because the treated residues are currently managed only on-site and are not likely to be managed off-site in the foreseeable future. In addition, the following analysis does not consider the risks associated with variations in waste management practices or potentially exposed populations in the future because of a lack of data on which to base projections of future conditions. Alternative practices for the management of treated chrome roast/leach residue, however, are discussed in Section 4.5.

Ground-Water Release, Transport, and Exposure Potential

As discussed above, leachate from the treated chromium residue contains five constituents in concentrations that exceed the risk screening criteria. However, given the existing residue management practices and the neutral pH conditions that are expected to exist in and under the waste management units, vanadium, aluminum, and manganese have a strong tendency to bind to soil. These three constituents in leachate from the treated residue, therefore, are relatively immobile in ground water (in the event that they are released to ground water). Moreover, the residue treatment process employed is designed to reduce chromium to the trivalent form, which is relatively immobile in typical ground-water systems.[15] Therefore, among the constituents of potential concern in leachate from the treated residue, only arsenic would be expected to be readily transported in typical ground-water environments, if released.

Both sodium dichromate production facilities manage the treated residue in units that have no engineered ground-water release controls such as liners or leachate collection systems. However, the ground-water release and transport potential of these units differ significantly:

- The OCC plant in North Carolina discharges the residue slurry into a 49 hectare (120 acre) quarry that is 12 meters deep. The depth of supernatant liquid in this impoundment provides a large hydraulic head that may produce a considerable force to drive liquids from the quarry into the underlying aquifer. Because the quarry is located in karst terrain (i.e., irregular topography characterized by solution features in soluble rock), any liquids released from the quarry to the aquifer located six meters beneath the quarry could potentially flow long distances directly through conduits in the bedrock (i.e., with minimal contaminant dilution and attenuation) to potential exposure points.
- The ACC facility in Texas discharges the residue slurry to an unlined disposal area that has little or no standing water except during storm events and immediately following deposition of fresh residue slurry. Water is removed from the unit via a network of drainage ditches, by evaporation, and by seepage into the ground. Although there is little hydraulic head to drive the flow of contaminants from the unit, both slurry water and stormwater potentially can leach

[15] For all other mineral processing wastes evaluated in this report, chromium is assumed to be present in its hexavalent form and, therefore, to be relatively mobile in ground water.

contaminants from the residue into the subsurface. The potential for slurry water and stormwater to infiltrate to ground water from this unit may be limited to some degree by the presence of relatively impermeable subsurface materials (i.e., composed primarily of clay) in the vicinity of the site.

Given these management unit and hydrogeological characteristics, the potential for seepage from the disposal units to migrate into ground water is relatively high at the North Carolina facility and moderate at the Texas facility. Ground-water monitoring data further support this assessment. Monitoring of ground water at the North Carolina facility has indicated that drinking water standards for chloride and pH have been exceeded downgradient (but not upgradient) of the waste management area. While these contaminants are not associated with the treated chromium residue, the presence of contaminants in the ground water indicates the potential for contaminants to leach into ground water at this site.[16] Ground-water contamination has also been documented at the Texas facility (see Section 4.3.2). Although the ground-water contamination at the Texas facility has not been attributed to the treated residue management unit, the presence of contamination again indicates that hydrogeologic conditions at this location do not preclude the potential release of residue constituents to ground water.

Ground-water flow in karst terrain, such as that at the OCC plant, is typically characterized as conduit flow that does not provide the intimate contact between aquifer material and ground water that occurs in typical porous media aquifers. Consequently, the constituents of potential concern (i.e., trivalent chromium, vanadium, aluminum, and manganese) that would not be mobile in typical ground-water environments can migrate more readily in karst limestone aquifers, and may be mobile along with arsenic at the OCC plant.

Currently, there are no residential or public water supply withdrawals from ground water within 1.6 km (1 mile) downgradient of either facility. Therefore, current human health risks resulting from drinking water exposures are not expected. Potential releases of arsenic, chromium, vanadium, and manganese from the waste to the aquifer at the OCC plant, and potential releases of arsenic at the ACC plant could restrict potential future uses of the ground water, but this threat is very minor given the low concentration of the waste leachate. In theory, contaminants migrating into ground water at the OCC facility could remain at levels above the screening criteria for relatively long distances because conduit flow does not disperse contaminants as readily as diffuse flow in porous media. However, in reality, any contaminants released to ground water at the OCC facility are likely to discharge directly into the adjacent northeast Cape Fear River, as described in the next section.

Surface Water Release, Transport, and Exposure Potential

Constituents of potential concern in treated roast/leach residue could theoretically enter surface waters by either migration of leachate through ground water that discharges to surface water, or direct overland (stormwater) run-off of dissolved or suspended materials. As discussed above, arsenic, chromium, aluminum, manganese, and vanadium leach from treated chrome residue at levels above the screening criteria. Given the characteristics of the units currently used to manage this waste at the two sodium dichromate production facilities and the hydrologic setting of the plants, the potential for releases of treated residue constituents to surface waters varies between the two plants.

The OCC plant in North Carolina is located adjacent to the Northeast Cape Fear River. Because the waste is managed as a sludge at the bottom of a quarry that is 12 meters deep, however, it is unlikely that overland flow of stormwater run-off could carry the waste to the river. Ground-water discharge to surface water could potentially release contaminants from the residue sludge to the river at concentrations above the screening criteria. However, resulting contaminant concentrations in the river downstream of the facility are expected to be negligible because the large flow of the river (1,250 mgd) can provide substantial dilution, and the constituents that exceed the screening criteria exceed it by a factor of less than five.

The ACC plant in Texas is located less than 50 meters from the Corpus Christi shipping channel. Releases from the treated residue disposal area are expected to be moderated by run-on/run-off controls designed to restrict surface run-off of stormwater and slurry water from the unit. As discussed above, the potential for contamination of ground

[16] The facility did not provide information on the possible sources of the observed ground-water contamination.

water is moderate at this facility, and, consequently, contaminated ground water potentially could discharge to the shipping channel. However, because the Agency's comparison of treated chrome residue concentrations to screening criteria does not indicate any potential impacts on saltwater ecosystems or restrictions on potential beneficial uses of saltwater, threats to the shipping channel water quality from treated chromium residue appear unlikely.

Air Release, Transport, and Exposure Potential

EPA's comparison of constituent concentrations to screening criteria did not identify any potential constituents of concern for the air pathway. Consequently, if airborne releases were to occur, possibly due to future removal of the residue sludge from the current management areas, chrome residue should pose no human health threats via the air pathway. Air pathway threats from current management of the residue at the OCC plant are further diminished because the waste is managed as a sludge at the bottom of a quarry, submerged beneath a liquid.

Proximity to Sensitive Environments

Both the OCC and ACC plants are located in environments that are vulnerable to contamination or have high resource value. Because the OCC plant is located in a 100-year floodplain, large releases occasionally could occur in the event of a large flood. The OCC plant also is located in an area of karst topography, which may permit the ready transport of contaminants if they are released to ground water. Both sodium dichromate production facilities are within 1.6 km (1 mile) of a wetland area. However, because the ground-water and surface water release potential at the ACC facility is considerably smaller, only the wetland area near the OCC plant may be potentially threatened by releases from the residue. Wetlands are commonly entitled to special protection because they provide habitats for many forms of wildlife, purify natural waters, provide flood and storm damage protection, and afford a number of other benefits.

Risk Modeling

The intrinsic hazard of the treated residue is generally low because the residue does not exhibit any of the four characteristics of a hazardous waste and contains only five constituents that exceed the screening criteria by a narrow margin (less than a factor of five). Migration into ground and surface water is possible at both sites, but it is not expected to cause significant human health or environmental impacts for the reasons outlined above. In addition, there are no documented cases of damage attributable to the treated residue (as presented in the next section) and the Agency's modeling of other wastes that appear to pose a greater hazard suggest that the risks posed by the treated residue are low. For all of these reasons, EPA has concluded that the potential for treated residue from roasting/leaching of chrome ore to pose significant risk to human health or the environment is moderate to low. (See sections 4.3.3 and 4.7 for additional discussion.) Therefore, the Agency has not conducted a quantitative risk modeling exercise for this waste.

4.3.2 Damage Cases

State and EPA regional files were reviewed in an effort to document the performance of waste management practices for treated residue from the roasting/leaching of chrome ore. The file reviews were combined with interviews with Texas and North Carolina State and EPA regional regulatory staff. Through these case studies, EPA found no documented environmental damages attributable to management of the treated residue from chrome ore processing. Ground-water contamination has been identified at the American Chrome and Chemical facility, but it is not clear to what extent current waste disposal practices, historical waste disposal practices (which involved management of an untreated residue), and/or neighboring facilities are the source of the contamination.

Contacts with State agencies and review of State files also revealed that historical management practices of the <u>untreated</u> chrome ore processing residues have created numerous sites where remediation (by removal or other means) is planned or in progress.[17] Examples include: (1) the Allied Chemical plant in Baltimore, MD; (2) the city of Baltimore's Patapsco Wastewater Treatment Plant and other sites on Baltimore Harbor where untreated chrome ore residues from the Allied Chemical facility were used as fill material; and (3) more than 100 sites in Hudson County, New Jersey (includes Jersey City, Kearny, and Secaucus), where use of the untreated residues (from three facilities -- Allied Chemical Corp., PPG Industries, and Diamond Shamrock Co.) in an urban setting resulted in chromium contamination of surficial soil, with associated contamination of ground and surface water, sediment, building walls, and ambient air.

4.3.3 Findings Concerning the Hazards of Treated Residue from Roasting/Leaching of Chrome Ore

Review of the available data on treated residue indicates that none of the waste's constituents are present at levels above the screening criteria in samples of the treated residue solids. The available data also indicate that the treated residue does not exhibit any of the four characteristics of hazardous waste. Data on constituent concentrations in laboratory leachate from the treated residue indicate that concentrations of chromium, vanadium, aluminum, manganese, and arsenic occur above screening criteria. None of the constituents, however, are present at a concentration more than five times a screening criterion, and arsenic is present at a concentration that is just equal to its human health screening criterion. Given the very conservative nature of these screening criteria, these low contaminant concentrations in leachate from the treated residue would pose a significant risk only under extreme exposure conditions.

The potential for release, transport and exposure is notably different at the two currently active facilities. The ground-water release potential is high at the North Carolina facility and moderate at the Texas facility, but the potential for risks resulting from drinking water exposure is low at both facilities because of the low concentration of the leachate and because any contaminated ground water is likely to discharge directly into adjacent surface waters without being withdrawn for drinking. At the North Carolina facility, it is unlikely that release to surface waters via overland flow would occur, but migration through ground water that discharges to surface water could occur. No significant impacts would be expected, however, due to the large flow of the river. At the Texas plant, erosion to surface waters should be mitigated by run-off controls, but releases through ground-water discharge to the Corpus Christi Shipping Channel could potentially occur. The shipping channel contains saltwater, and comparison of leachate concentrations to the screening criteria did not indicate any potential impacts to saltwater ecosystems. No constituents of potential concern were identified for releases to air.

Based on the relatively low intrinsic hazard of the waste, the low potential for release, transport, and exposure, and the absence of documented cases of danger to human health or the environment, EPA has tentatively concluded that the hazard posed by treated residue from the roasting/leaching of chrome ore is relatively low. Accordingly, only limited discussions of current applicable regulatory requirements, alternative waste management and utilization, and costs and impacts are provided below.

4.4 Existing Federal and State Waste Management Controls

4.4.1 Federal Regulation

Although there are a number of Federal statutes and regulations which apply to various industrial wastes generally (including those from ore mining and dressing and certain types of primary metal production), there are none that specifically address solid wastes from chrome ore processing. It should be noted, however, that untreated roast/leach residue and any additional wastes generated by chrome processing operations that may exhibit a characteristic of hazardous waste are subject to Subtitle C of RCRA, as of the effective date (July 23, 1990) of the final rule establishing the boundaries of the Mining Waste Exclusion (55 FR 2322, January 23, 1990).

[17] EPA has previously determined that untreated chromium roast/leach ore residue is not a low hazard waste and, therefore, it is not within the scope of this Report to Congress. (See 54 FR 36592, September 1, 1989.)

4.4.2 State Regulation

The nation's two chromium facilities are located in two states, North Carolina and Texas, both of which were selected for regulatory review for the purposes of this report (see Chapter 2 for a discussion of the methodology used to select states for detailed regulatory study). Both North Carolina and Texas have adopted the federal exclusion from hazardous waste regulation for mineral processing wastes.

North Carolina does not regulate roasting/leaching residue from chrome ore under its solid waste regulations, but does address this waste under state water pollution control regulations. North Carolina has an approved NPDES program and requires that its single chromium facility maintain a "no discharge" permit for the impoundments used for settling and disposing of the treated residue. Under the terms of this permit, the facility must undertake activities such as weekly EP-toxicity testing, ground-water monitoring, and personnel certification. The permit also stipulates that a closure plan must be submitted for approval three months prior to closure of the impoundment. Finally, the facility's impoundment used for the disposal of treated roasting/leaching ore residue is not subject to specific requirements in the facility's air permit, though a recently promulgated toxic air pollutants regulation may result in the application of more stringent requirements.

Texas classifies roast/leach residue from chrome ore as industrial solid waste. Because the chromium facility in Texas disposes of its roast/leach ore residue on land that is both within 50 miles of the facility and controlled by the facility owner/operator, the state has not required that the facility obtain a solid waste disposal permit. The facility is required to notify the state of its waste management activities, however, and may be required to submit additional information such as waste characterization data. Moreover, all discharges to surface water in the state must be permitted under both federal NPDES and state water quality discharge permits. Finally, although the single chromium facility in Texas maintains an air permit, the permit does not specifically address the roasting/leaching residue surface impoundments managed at the facility.

In summary, both of the states with chromium facilities, North Carolina and Texas, regulate the chrome ore roasting/leaching residues generated at those facilities under solid waste and/or water quality regulations. Of the two states, North Carolina appears to be somewhat more comprehensive in the kinds of environmental controls required and the stringency of those controls. Finally, neither of the facilities' state-issued air permits specifically address, at this time, the roasting/leaching residue management and disposal units used by the facilities, though North Carolina may impose more stringent requirements under newly promulgated toxic air pollutants regulation.

4.5 Waste Management Alternatives and Potential Utilization

As noted above, while the treated residue from roasting/leaching of chrome ore could pose a risk under a very conservative set of conditions, the risk analysis indicates that significant impacts are unlikely. Consequently, the issue of how sodium dichromate producers might modify their operations or waste management practices or be stimulated to develop alternative uses for the treated roast/leach residue in response to prospective hazardous waste regulation is not applicable. Nevertheless, EPA did search the literature for information on research into alternatives for disposal and potential utilization of the treated residue, but no relevant information was identified.

4.6 Cost and Economic Impacts

Because the available data indicate that treated residue from roasting/leaching of chrome ore does not exhibit any of the characteristics of hazardous waste and is unlikely to pose significant risks to human health and the environment, the issue of how waste management costs might change because of new requirements associated with regulation under RCRA Subtitle C and what impacts such costs might impose upon affected facilities has not been investigated.

4.7 Summary

As discussed in Chapter 2, EPA developed a step-wise process for considering the information collected in response to the RCRA §8002(p) study factors. This process has enabled the Agency to condense the information presented in the previous six sections of this chapter into three basic categories. For each special waste, these categories address the following three major topics: (1) potential for and documented danger to human health and the environment; (2) the need for and desirability of additional regulation; and (3) the costs and impacts of potential Subtitle C regulation.

Potential and Documented Danger to Human Health and the Environment

The intrinsic hazard of the treated residue from roasting/leaching of chrome ore is relatively low compared to other mineral processing wastes studied in this report. The treated residue does not exhibit any of the four characteristics of hazardous waste. Data on constituent concentrations in solid samples of the waste also do not indicate any exceedance of the screening criteria used in this analysis. Data on constituent concentrations in laboratory leachate from the treated residue, however, indicate that five constituents are present in concentrations above the conservative screening criteria. However, none of these constituents are present at a concentration more than five times the screening criterion, and given the conservative nature of these screening criteria, these low contaminant concentrations in leachate from the treated residue would pose a significant risk only under extreme exposure conditions.

In addition to the relatively low intrinsic hazard of this waste, current management of the waste at the facilities in North Carolina and Texas appears to limit the potential for the waste to threaten human health or the environment. Although the ground-water release potential is relatively high at the North Carolina facility and moderate at the Texas facility, the potential for exposure resulting from drinking water is low at both facilities because of the low concentrations of the waste leachate and because any contaminated ground water is likely to discharge directly into adjacent surface waters without being withdrawn for drinking (i.e., the waste management units are located very near surface waters and it is unlikely ground water would be withdrawn between the management units and the point of discharge into the surface water). At the North Carolina facility, releases to surface waters via overland flow are unlikely, and releases through ground-water discharge would not be expected to produce significant impacts because of the large flow of the river adjacent to the plant. At the Texas plant, overland releases to surface waters would be mitigated by run-off controls, and no adverse impacts are expected in the event of ground-water discharges to the adjacent saltwater system because constituent concentrations in leachate from the treated residue are below concentrations that threaten saltwater organisms.

The lack of documented cases of damage caused by the treated residue confirms that the waste, as currently managed, appears not to cause significant health or environmental impacts. Review of State and EPA Regional files and interviews of State and EPA Regional regulatory staff did not produce any evidence of documented environmental damages attributable to management of treated residue at the Texas or North Carolina facilities.

Likelihood That Existing Risks/Impacts Will Continue in the Absence of Subtitle C Regulation

The relatively low intrinsic hazard of the waste and the current waste management practices and environmental conditions that currently limit the potential for significant threats to human health and the environment are expected to continue to limit risks in the future in the absence of Subtitle C regulation. The characteristics of this waste are unlikely to change in the future, and despite the fact that this analysis is limited to the two sites at which the waste is currently managed, EPA believes that the conclusion of low hazard can be extrapolated into the future because the environmental conditions in which the waste is managed are unlikely to change. Management of treated residue is unlikely to expand beyond the two locations currently in use for three reasons. First, the quantity of material involved makes it unlikely that the treated residue from roasting/leaching of chrome ore would be removed from the impoundments for disposal elsewhere. Second, current trends in industry growth indicate that construction of additional sodium dichromate production facilities is not likely. Third, the treated roast/leach residues have historically not been used off-site, and no viable approaches to utilization of the treated residue have been identified.

At the facility in North Carolina, the potential for increased risks in the future is further restricted by substantial State regulation of the treated residue disposal unit. The requirements for this unit, which are incorporated in a state-administered water quality permit, include no discharge from the impoundments used for settling and disposal of the treated residue, weekly EP-toxicity testing, ground-water monitoring, a compliance boundary where water quality standards must be met, and operation of the unit by a certified operator. At the Texas facility, in contrast, the State's application of environmental control requirements for waste management activities is limited.

Costs and Impacts of Subtitle C Regulation

Because of the low risk potential of treated residue from roasting/leaching of chrome ore, the general absence of documented damages associated with this material, and the fact that this waste does not exhibit any characteristics of hazardous waste, EPA has not estimated the costs and associated impacts of regulating treated residue from roasting/leaching of chrome ore under RCRA Subtitle C.